
वस्त्रादि — कृत्रिम रेशा धागा —
शुष्क-गर्म हवा में संकोचन का निर्धारण
(प्रशोधन के बाद)

**Textiles — Synthetic Filament
Yarns — Determination of
Shrinkage in Dry-hot Air
(After Treatment)**

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FOREWORD

This Indian Standard was adopted by Bureau of Indian Standards, after the draft finalized by the Physical Method of Test Sectional Committee had been approved by the Textile Division Council.

Manmade thermoplastic filament yarns can be shortened by various influencing factors during processing and use. Usually heating, wetting, or wet-heating process that leads to shrinkage. Depending upon raw material, a filaments reacts more strongly to heat, moisture or moist heat.

The dimensional stability of manmade thermoplastic filament yarns is decided by the residual shrinkage present in the yarn. The residual shrinkage is measured by either boiling water method or hot air method. Shrinkage is an important property because it determines the fabric behavior during end use.

This standard covers the general method of skein preparation, method of test for determining shrinkage in hot air.

Considerable assistance has been derived from ISO 18067 : 2015 'Textiles — Synthetic filament yarns — Determination of shrinkage in dry-hot air (after treatment)' in the formulation of this Indian Standard.

The composition of the Committee responsible for the preparation of this standard is given in Annex A.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

TEXTILES — SYNTHETIC FILAMENT YARNS — DETERMINATION OF SHRINKAGE IN DRY-HOT AIR (AFTER TREATMENT)

1 SCOPE

1.1 This standard specifies methods for the determination of dry-hot air shrinkage (after treatment) of synthetic filament yarns, by skein method and single-end method. The skein method provides two forms of measurement which are of manual and automatic types. The single-end method gives the result by manual measurement. In case of dispute, manual measurement procedure is to be used.

1.2 This standard is applicable to synthetic filament yarns of linear density less than 3 000 dtex and is not applicable to partially oriented yarns.

2 REFERENCES

The standard given below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
6359 : 1971	Method for conditioning of textiles

3 TERMS AND DEFINITIONS

For the purposes of this document, the following terms and definitions shall apply.

3.1 Shrinkage in Dry-hot Air (After Treatment) — It is decrease in length of a specimen as a result of thermal treatment in dry-hot air, expressed as a percentage of its original length, which is measured under tension before and after treatment.

4 PRINCIPLE

Under specific condition, a test specimen is treated in dry-hot air. Shrinkage is calculated as variation in length, measured before and after treatment.

5 APPARATUS AND MATERIALS

5.1 Skein winding Reel

Which meets the following requirements:

- a) $1\,000 \pm 2.5$ mm reel circumference, driven either automatically or manually;
- b) A traversing mechanism to avert overlapping when several skeins are wound at the same time;
- c) A tensioning device to maintain tension within the recommended limits, accurate to within ± 10 percent;
- d) A device to count reel revolutions, preferably capable to stop winding automatically and warn when nearing the specified number of reel revolutions; and
- e) A mechanism to reduce the reel circumference for easy removal of the skein.

5.2 Length-measuring Stand

Which meets the following requirements:

- a) A stand for measuring specimen length of at least 1 mm gauge length;
- b) A millimetre scale to determine specimen length, accurate to within ± 1 mm;
- c) A steel hook or a clamp, where the top of the hook or the lower side of the clamp (where the specimen hung from) is positioned in line with the zero index of the scale; and
- d) Tensioning weights with hooks or clamps for applying tensile force to specimens, accurate to within ± 10 percent.

5.3 Automatic Shrinkage Tester

Which meets the following requirements:

- a) Automatically applies specified tension, measures specimen length, and calculates the shrinkage based on length values;
- b) 0.05 mm resolution of length measurement; and

Table 1 Number of Lot Sample and Laboratory Sample
(Clause 6.1)

Sl No.	Number of Containers in the Consignment	Number of Containers in the First Selection	Number of Containers taken for Consignment Sample	Number of Packages Sampled from Each Container	Number of Packages Chosen for Laboratory Sample
(1)	(2)	(3)	(4)	(5)	(6)
i)	10 or less	all	all	see note below	20 approx
ii)	11 to 20	10	10	2	20
iii)	21 to 40	20	10	2	20
iv)	more than 40	40	20	1	20

NOTE — Take an equal number of packages from each container. The number of packages for laboratory sample shall be at least 20. If the consignment includes less than 20 packages, sample all of them.

- c) A specimen holder for suspending specimens more than 600 mm high, which can consistently hold 2.5 cN load per skein for the duration of the testing procedure with several skeins arranged and tested in succession.

NOTE — Other mechanical devices may be used for the test provided that equivalent results are obtained.

5.4 Ventilated Oven

Which meets the following requirements:

- A holder for suspending specimens in the oven more than 600 mm high during manual measurement, with test specimens adequately spaced apart so as not to touch each other and the interior sides of the oven;
- At least 600 mm high interior to accommodate the holder in an upright position, with occupied space not more than 80 percent of the volume;
- A thermometer to measure and record the hot air temperature in the vicinity of the specimens; and
- Adequate ventilation to maintain oven temperature to an accuracy of $\pm 3^{\circ}\text{C}$.

6 SAMPLING AND PREPARATION OF THE TEST SPECIMEN

6.1 Sampling

Sampling shall be performed as follows:

- In accordance with the directions given in the material specification;
- Bulk laboratory sample shall be taken on demand; and
- Number of lot sample and laboratory sample are listed in Table 1.

6.2 Preconditioning and Conditioning

6.2.1 The standard atmosphere for conditioning and testing shall be as specified in IS 6359.

6.2.2 When actual moisture regain exceeds commercial value, the test specimen shall be preconditioned. Specimens shall be exposed in standard atmosphere for more than 30 min to reach moisture equilibrium.

6.3 Preparation of the Test Specimen

6.3.1 Skein Method

6.3.1.1 Turns of reel

The number of turns needed to obtain the set linear density of the skein is calculated according to formula (1):

$$n = \frac{T_t}{2 \times T} \quad \text{---- (1)}$$

Where,

n = number of turns, rounded to nearest whole number;

T_t = set linear density of the skein, in dtex (see Table 2); and

T = nominal linear density of the specimen, in dtex.

Table 2 Set Linear Density of the Skein
(Clause 6.3.1.1)

Sl No.	Nominal Linear Density of the Specimen	Set Linear Density of the Skein
(1)	(2)	(3)
i)	≤ 500 dtex	2 500 dtex
ii)	> 500 dtex ~ 3 000 dtex	10 000 dtex

6.3.1.2 Reeling

Discard yarns on the outer layer of the package. Lead the yarn through the tension device and fix the end on the clip of the reel. Smoothly reel the skein using uniform tension lower than the specific tension [calculated as Formula (3)] and reel the specific turns (see 6.3.1.1).

Cut the yarn close to the clip and tie two yarn ends together, without stretching the yarns. Remove the skein from the reel carefully and avoid tangling.

The test specimens are conditioned in a loose and tension-free state as specified in 6.2. It is recommended that polyester and polypropylene specimens shall be conditioned for more than 2 h, while polyamide specimens for at least 3 h.

6.3.2 Single-end Method

Discard yarns on the outer layer of the package. Cut yarn in a length of 60 cm - 70 cm from the package.

The test specimens are conditioned in a loose and tension-free state as specified in 6.2. It is recommended that polyester and polypropylene specimens shall be conditioned for more than 2 h, while polyamide specimens for at least 3 h.

6.4 Number of Specimens

For bulk laboratory samples, the minimum number of specimens shall be two from each package and a total of 10 from one lot.

For batch laboratory samples, prepare one specimen from each package and not less than 20 total. In case of arbitration, prepare three specimens from each package and not more than 60 total.

7 TESTING CONDITIONS

7.1 Dry-hot Air Treatment Conditions

Dry-hot air treatment conditions vary for different kinds of yarns. Recommended temperature and treatment duration are listed in Table 3.

For yarns not mentioned in Table 3, temperature and treatment time shall be determined as agreed.

7.2 Tension for the Test Specimen

Calculate the tension in skein method according to Formula (2):

$$F = P \times T_t \quad \text{---- (2)}$$

Where,

F = is the tension, in cN;

P = is the tension per unit linear density, in cN/dtex;

T_t = is the set linear density of the skein, in dtex.

Calculate the tension in single-end method according to Formula (3):

$$F = P \times T \quad \text{---- (3)}$$

Where,

F = is the tension, in cN;

P = is the tension per unit linear density, in cN/dtex;

T = is the nominal linear density of the yarn, in dtex.

Tension per unit linear density shall be:

a) non-textured yarns: (0.05 ± 0.01) cN/dex; and

b) textured yarns: (0.20 ± 0.04) cN/dtex.

For those filament yarns not applicable, tension will be determined as agreed.

7.3 Equilibrium Time for Test Specimen after Thermal Treatment

Test specimens shall reach moisture equilibrium after thermal treatment in standard atmosphere specified in 6.2.2.

Table 3 Hot Air Temperature and Thermal Treatment Time

(Clause 7.1)

Sl No.	Shape of the Yarns	Type of the Yarns	Hot Air Temperature (°C)	Thermal Treatment Time (min)
(1)	(2)	(3)	(4)	(5)
i)	Multifilament	Polyester, Polyamide 66	190 ± 3	15 ± 1
		Polyamide 6	170 ± 3	15 ± 1
		Polypropylene	110 ± 3	15 ± 1
ii)	Monofilament	Polyester	180 ± 3	15 ± 1
		Polyamide 66	180 ± 3	10 ± 1
		Polyamide 6	150 ± 3	10 ± 1
		Polypropylene	110 ± 3	15 ± 1

It is recommended that polyester and polypropylene specimens shall be conditioned for more than 2 h, while polyamide specimens for at least 3 h.

8 TESTING PROCEDURE

8.1 Skein Method A (Manual Measurement)

8.1.1 Measuring the Initial Length of the Test Specimens

Hang one conditioned skein from the hook at the top of the length-measuring stand (see 5.2), with the knot placed at the hook.

Carefully add sufficient weight on the bottom of the skein, to produce the tension calculated in 7.2. This tension shall be reached slowly to prevent any over-tensioning.

Maintain the tension for (30 ± 3) s and measure the straightened length (L_0) to an accuracy of 1 mm.

Remove weight and skein after measurement. Take the skein and suspend it from a holder in the oven (see 5.4).

Repeat above procedures in sequence, till all skeins have been tested.

8.1.2 Thermal Treatment of the Test Specimens

Preheat the oven (see 5.4) to the specified temperature according to Table 3 in 7.1 and keep temperature steady. Place the holder into the oven quickly (within 5 s or less), to minimize the temperature decrease in the oven.

When the oven reaches the specified temperature, begin measuring treatment time as specified in 7.1.

8.1.3 Equilibrium after Thermal Treatment

After treatment, carefully take out the holder with skeins. Condition the skeins as specified in 7.3, with skeins in loose and tension-free state.

8.1.4 Measuring the Length of the Test Specimens after Treatment

Follow procedures in 8.1.1 and measure the straightened length (L_s) to an accuracy of 1 mm.

8.2 Skein Method B (Automatic Measurement)

8.2.1 Measuring the Initial Length of the Test Specimens

Hang the conditioned skeins sequentially from the hook at the top of the specimen holder (see 5.3), with knots placed at the hook.

Apply a 2.5 cN load to the bottom of each skein to avoid entanglement and hold skein downwards.

Place the specimen holder into the automatic shrinkage tester (see 5.3) and set tension as calculated in 7.2.

After automatically applying and maintaining the tension for (30 ± 3) s, measure the straightened length (L_0) of a skein to an accuracy of 0.1 mm.

Repeat auto-loading and auto-measuring procedure in sequence, until all skeins in the specimen holder have been tested.

8.2.2 Thermal Treatment of the Test Specimens

Following the procedures in 8.1.2, place the specimen holder with a 2.5 cN load applied to each skein into the oven and conduct thermal treatment.

8.2.3 Equilibrium after Thermal Treatment

Following the procedures in 8.1.3, condition the skeins on the specimen holder with a 2.5 cN load applied to each skein.

8.2.4 Measuring the Length of the Test Specimens after Treatment

Following the procedures in 8.2.1, place the specimen holder into the tester and measure the straightened length (L_s) of each skein to an accuracy of 0.1 mm.

8.3 Single-end Method

8.3.1 Measuring the Initial Length of the Test Specimens

Hang the conditioned single yarn sequentially from the clamp at the top of the length-measuring stand (see 5.2). Carefully add sufficient weight on the bottom of the yarn, to produce the tension calculated in 7.2. This tension shall be reached slowly to prevent any over-tensioning. Maintain the tension for (30 ± 3) s.

Mark yarn at the zero index and at the 50 cm index of the scale. Measure the distance between the two marks to get the straightened length (L_0) to an accuracy of 1 mm.

Remove weight and single yarn after measurement. Suspend the single yarn from the holder (see 5.4), with the middle part placed at the hook.

Repeat loading and measuring procedure in sequence, until all the single yarns have been tested.

8.3.2 Thermal Treatment of the Test Specimens

Follow the procedures in 8.1.2 to conduct thermal treatment.

8.3.3 Equilibrium after Thermal Treatment

Follow the procedures in 8.1.3 to condition the treated skeins.

8.3.4 Measuring the Length of the Test Specimens after Treatment

Follow the procedures in 8.3.1 to measure the distance between the two marks made before thermal treatment, which is the straightened length (L_s), to an accuracy of 1 mm.

9 CALCULATION AND EXPRESSION OF RESULTS

9.1 Calculation

The shrinkage in dry-hot air (HAS) is calculated according to formula (4):

$$HAS = \frac{L_0 - L_s}{L_0} \times 100 \quad \text{---- (4)}$$

Where,

HAS = is the shrinkage in dry-hot air, in percent;

L_0 = is the length of the test specimen before treatment, in mm; and

L_s = is the length of the test specimen after treatment, in mm.

The result is expressed as an arithmetic mean value of all the test specimens, accurate to the first decimal place.

10 TEST REPORT

The test report shall include the following information:

- a) A reference to this Indian Standard;
- b) All details necessary for the identification of the sample tested (including method of preparation, if applicable);
- c) Test conditions (temperature, treatment time, and tension);
- d) Test method selected and parameters set (including loading speed of automatic shrinkage tester);
- e) Test results (length of the test specimen before treatment, length of the test specimen after treatment, shrinkage in dry-hot air, and arithmetic mean value of all the test specimens);
- f) Any deviation, by agreement or otherwise, in the procedure specified; and
- g) Any unusual phenomenon observed.

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Physical Methods of Test Sectional Committee, TXD 01

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